NBL Engineering and Safety Requirements for Student Projects

Part A. Tools (Float Sample Grabber, Surface Sampling Device, Rock Chip Sampling Device)

Part B. Test Beds (Asteroid Simulant for Rock Chip Sample, Asteroid Simulant for Core Drill Sample)

Part C. Requirements that apply to both Tools and Test beds

A. Tools

1. All tools must have a tether loop which will allow the astronaut to use a tether with hooks (similar to a carabiner hook) to restrain the tool

2. All tools must be operable with EVA gloved hands (like heavy ski gloves)

3. Tools must not have holes or openings which would allow/cause entrapment of fingers

4. All pressure systems shall be constructed from COTS components that are rated for the maximum operating pressure OR comply with ASME standards. Unique components not covered by the ASME standards shall be designed to a Factor of Safety of 4 to burst and complete stress analysis reports for those components shall be required.

5. Hydraulic Power Requirements

   a. The following fluids are approved for use in hydraulic systems:
      i. Water
      ii. Biodegradable Food-Grade Hydraulic Oil ISO Grade 32/46, SAE Grade 20, McMaster-Carr part# 3499K22

   b. Maximum hydraulic pressure allowed is 150 psig
   c. Hydraulic pump must be part of the safety review
      i. They must have a pressure relief valve installed before the pressure regulator.
      ii. The pump must have a regulator in place and set to 150 psig or less.
      iii. Pumps with any sign of external rust or deterioration will not be accepted.
      iv. All wiring must be secure.
      v. All guards must be in place.
      vi. Hydraulic pumps may run off of the electrical outlet identified below

6. Pneumatic Power Requirements

Student projects will be allowed to connect to the NBL's compressed air (shop air) system:

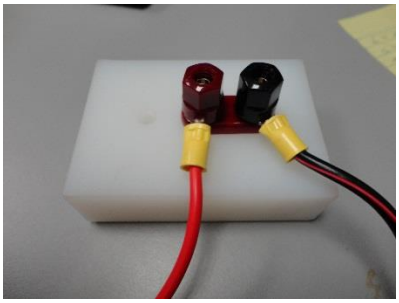
a. Pressure: 125 psig
b. NBL Shop Air Connector details:
    i. Grainger: Coupler Plug, (M)NPT, Item# 1HLZ8, Mfr. Model# A73440-BG
        Note: the female P/N is 1HLZ9
    ii. Quick Coupler Body, (F)NPT, Steel Item# 1HUK7, Mfr. Model# A73410-BG
c. NASA will supply the umbilicals

7. Electrical Power

a. Student projects will only be allowed to connect to the NBL's electrical power source: the interface we provide is a 12vdc 25 amp power supply. The interface connection will consist of positive and negative female banana plug connections (see photo). No other electrical power sources will be allowed.

b. Tool must incorporate a verifiable barrier to electric shock

NBL's Banana plug receptacle (electrical power):



Example banana plug connectors:

B. Test Beds

a. Test Beds must be stable during use on the floor in a 1-G environment (i.e. does not need additional support)

b. Test beds should allow transport to/from the pool deck via a forklift, if required

c. Test beds shall include shackle or lift point features to allow lifting the hardware into/out of the pool and restraining the testbed in the pool

d. Lifting - Lift points yield strength Factor of Safety = 4

C. Both Tools and Test Beds

e. Environmental Condition - NBL Pool Use:

i. A totally submerged condition in water that contains a range of 0.5 to 3.5 parts per million of free chlorine

ii. Ambient temperature range: +82° F (27.8° C) to +88° F (31.1° C)

iii. It is anticipated that some of the projects will be tested on the pool floor at a depth of 40 feet

b. Acceptable materials for use in the NBL

i. Allowable materials: typical engineering metal alloys (e.g. stainless steel, aluminum, titanium), plastics, composites, or soft good materials are acceptable for short term testing in the pool.

ii. Allowable lubricants, coatings, foam, or adhesives are shown in Attachment 1

iii. Other materials (e.g. gels) must be approved for use in the pool

c. Sharp Edges and Protrusions

i. Because of the potential for personal injury to diving support personnel and damage to the EVA suit, the mockup components shall not contain sharp edges and items capable of cutting or puncturing items coming into contact with them

ii. Avoid (or protect the handler from) pinch points and/or sharp edges

iii. The hardware shall be designed to specify manufacturing to remove burrs, break all sharp edges and round all corners

d. Water Entrapment - Mockups and hardware shall be designed with drain holes or geometry to allow the free flow of air and water as required to support submersion and removal to and from the NBL pool

e. Labels - The hardware provided shall have labels as follows:

i. Mate/de-mate alignment marks, operation indicators, as required

ii. Caution and warning tags for Hazard areas (i.e., pinch points, sharp edges, etc.).

iii. Hardware identification

iv. Additional safety labels may be requested by Test Readiness Review (TRR).

f. Loads – the hardware must withstand normal handling or kickloads and not present a safety hazard

ATTACHMENT 1 – NBL MATERIAL LISTS

Material Designation	Manufacturer
DOW Polystyrene Highload 60 Grade Blue Foam (64 lb/ft3 buoyancy)	Ryder Insulation Corporation
Last-A- Foam (20 lb/ft3 buoyancy)	General Plastics Mfg Corporation

Table 17: NBL Approved Foam Material List

Product	Suggested Vendors
Carboline 139 (Paint)	Carboline Company
Carbomastic 15M500 and 890	Carboline Company
Dupont 25P	Briggs Weaver
Ethone M-0-N (Marking Ink)	
Ethone M-5-N (Marking Ink)	
Ethone M-9-N (Marking Ink)	
Hi-Solids Catalyzed Epoxy	The Sherwin-Williams Company
NSP 120	NSP Specialty Products
Plasite 7122 (Paint)	Wisconsin Protective Coatings Corp.
UT Plast Super (non-epoxy)	UTP Welding Technology

Table 19: NBL Approved Coatings Material List

Product	Suggested Vendors
3M Adhesive Sealant Fast Cure 5200	N/A
3M Spray Adhesive	N/A
Dexter 0151 Hysol Epoxi-Patch Structural Adhesive	N/A
GE Translucent RTV 108 Silicone Rubber Adhesive Sealant	N/A

Labels: Thermatab Markers, THT-107-423	BRADY Worldwide 1-800-537-8791 www.bradyid.com

Product	Suggested Vendors
Loctite 608 Hysol Epoxi-Patch Adhesive	N/A
Plexis MA 422 FRP adhesive	N/A
PVC Heavy Duty Cement.	N/A

Table 20: NBL Approved Miscellaneous Items

Material Designation	Manufacturer
Braycote 601	Castrol Specialty Prod.
Braycote 602	Castrol Specialty Prod.
Braycote 803RP	Castrol Specialty Prod.
Christo-lube MCG-117	Lubrication Tech. Inc.
Halocarbon 25-10M	Halocarbon Corp.
Halocarbon 25-20M	Halocarbon Corp.
Halocarbon 25-5S	Halocarbon Corp.
Halocarbon 25-5SI	Halocarbon Corp.
Halocarbon 27S	Halocarbon Corp.
Halocarbon X90-10MS	Halocarbon Corp.
Krytox 280 AC	Dupont
Kyrtox 240 AC	Dupont
LOX-8	Fluoramics Inc.
Lubricant / Tef-Gel PTFE 9002-84-0	Ultra Safety Systems Inc.
Mobil – 28	Mobile
SAF-T-EZE	SAF-T-EZE Div, STL Compound Corp
Tiolube 460 Dry Film Lubricant	Tiodize Co., Inc., Huntington Beach, CA
Tiodize Type II (Titanium Hard Coat)	Tiodize Co., Inc., Huntington Beach, CA
Tiodize Type IV (Tiodize Type II plus Tiolon X40 Teflon coating)	Tiodize Co., Inc., Huntington Beach, CA

Table 21: NBL Approved Lubricants